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# Geospatial Land Use Land Cover Changes across Pakistan- A review

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## ABSTRACT

Change is an inevitable process in nature. The face of land is constantly changing due to natural and anthropogenic activities. Land use Land cover changes occur across Pakistan that have been studied in this paper with the context of a review of geospatial datasets with difference time spans of a minimum of 8 years and a maximum of 47 years. A literature survey was done to conclude various studies of different sites in Pakistan, including major cities, coastal areas, river basins, deforestation, reforestation, and areas of agricultural importance. Results show that there is a continuous increase in the built-up structure of all studied sites, the receding status of agricultural areas in Multan, deforestation of mangroves in Frontal Karachi coast and Thatta district, deforestation of juniper in Ziarat, deforestation in Swat Muzaffarabad, Jhelum, and Islamabad, reforestation of chilghoza in Sherani district occur within studied time span. Agriculture status improved in Jhelum, Islamabad, Malir Basin, and district Thatta. This paper will provide particular enlightenment on the regional situation of LULC changes across Pakistan.

**Keywords:** Land Use Land Cover Change (LULCC), Geospatial Datasets, Literature Survey, Regional datasets

## INTRODUCTION

Land use and land cover change are two distinct categories. Land use refers to the human use of land and is thoroughly studied by social scientists. The land cover represents the physical and biological aspects of the land and is extensively researched by natural scientists (Meyer et al.,1992). Land cover analyses and land-use transformations, which are primarily related to population expansion, are regarded as critical components for evaluating the relationship between population growth, land-use conversions, and environmental changes. The majority of the world's cities are getting more urbanized day by day, and human-caused land cover changes are changing the structure of land use in metropolitan regions. Pakistan now has a significant position in terms of population size, ranking sixth among world countries. It is common knowledge that as the population grows, urban areas expand. However, the pace of growth is affected by several numbers of different factors. It is understood, and various research indicates that increased human inhabitancy and resource consumption cause the urban land area to expand and change land use land cover (Khan et al., 2014). Land use refers to the many actions carried out by humans to divide the terrain into various patterns with corresponding modifications. (Carole et al., 1993).

It may be utilized to produce food, provide housing, provide entertainment, process materials, and so forth (Halder, 2013). Human actions are causing enormous changes in the terrestrial environment at breakneck speed, magnitudes, and spatial scales. Human-caused land-cover change is a significant source and component of global environmental change. Globally land is utilized for various essential human activities with significant geographical and economic importance. These include diverse forms of agriculture, livestock grazing, urban development, designated reserve and conservation areas, as well as the extraction of timber resources. These and other land uses have changed the global land cover (Turner et al., 1994). Along with its repeating nature, satellite remote sensing data have shown to be immensely valuable in mapping land use land cover patterns and changes over time. GIS technologies can quantify such changes even if the resulting geographical datasets have varied scales and resolutions. Since the introduction of Landsat 1 in the early 1970s, several attempts have been made to map changes in land use and land cover. Such research has aided in understanding the dynamics of human actions in space and time (Sarma et al., 2001).

## STUDY SITES

Pakistan emerged on the world map on 14th August 1947 as an independent sovereign state. The Islamic Republic of Pakistan consists of an area of 803,940 square kilometers (80394000ha) with a total population of 172.80 million (2008 Census). Its capital is Islamabad with a living ethnicity of 95% Muslims, and 5% others. Pakistan is located in South Asia. Pakistan's coastline is in the south and consists of 1046km. To the east of Pakistan is India which has a 2,912 km border with Pakistan. To the west of Pakistan is the Islamic Republic of Iran which shares a 909km boundary. To the northwest lies the Islamic Republic of Afghanistan, with a shared Durand line of 2,430 km. People's Republic of China in the northeast shared 523 km (Consulate General of Pakistan). This study includes various datasets and documents that are listed in Table 1 along with temporal and spatial coverage of LULC datasets. Available datasets detail is presented in Table 1 with the details of authors. The location map in Figure 1 represents the geographical

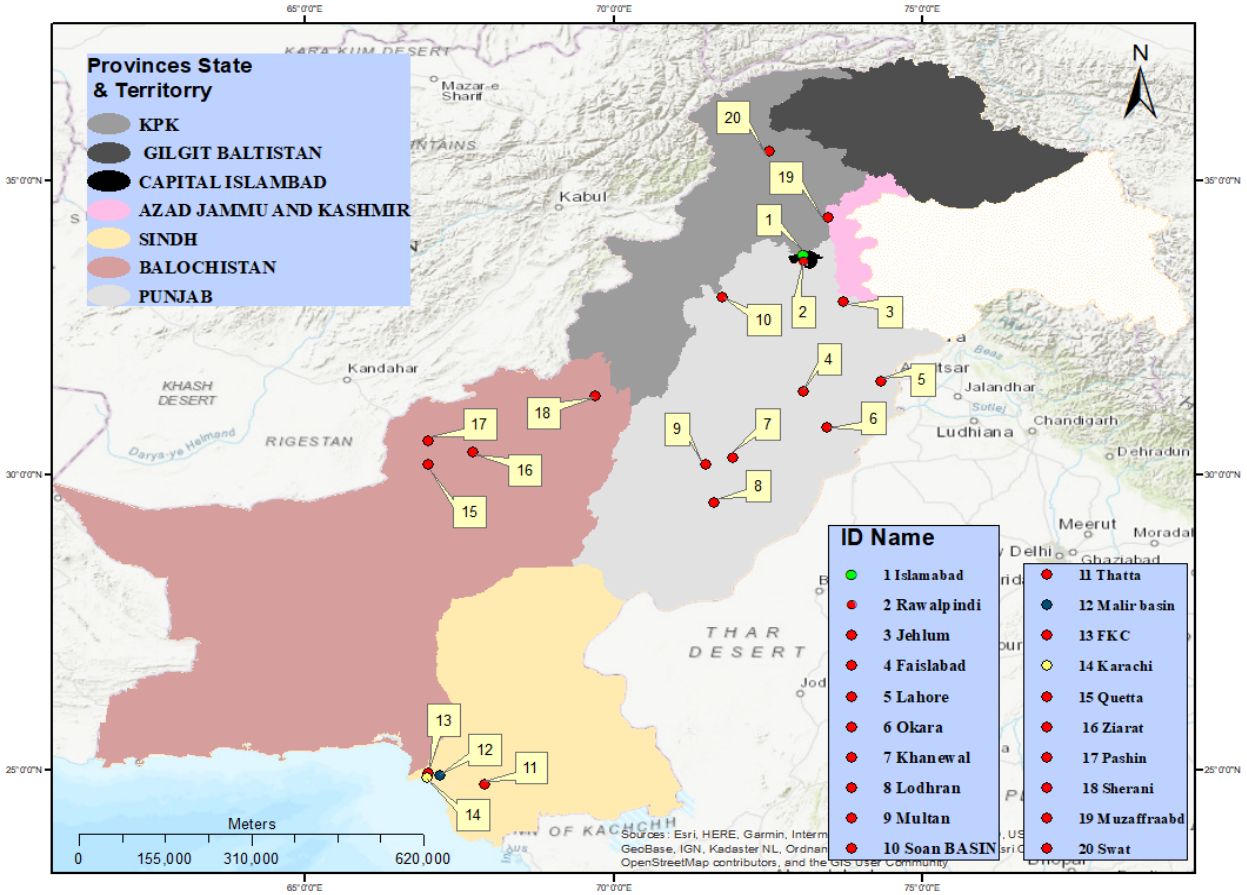


**Figure 1.** Areas of Interest (AOI) Pakistan Land Use Land Cover Transformation

distribution of available studies in Pakistan. These datasets are obtained from websites and journals with literature surveys from academic and research institutions. Most research is concerned with land cover change, forestland, urban and cropland areas.

## SELECTION OF DATA

### *Federal Area*

Islamabad is the capital city of Pakistan which was established in 1963. It is 480–550 meters above sea level and is located between 33°-28' and 33°-58' north latitude and 72°-48' and 73°-22' east longitude (Malik et al., 2010). Islamabad area can be divided into land use land cover classes of agriculture, built-up, barren land, forest areas, and water bodies. A study from 1992 to 2012 was carried out to detect changes in Pakistan's area of prime importance. Built-up area increases from 16,281ha to 51,039ha. Forest areas decreased from 12,136ha to 6138ha. The agriculture area increased from 10,336ha to 29,000ha. Barren area decreases from 49,789ha to 1678ha. Waterbody increased from 1416ha to 1579ha (Hassan et al., 2016). In another study, Lulc changes were detected from 1979 to 2019. The same agriculture, built-up, barren land, forest areas, and water bodies are studied. The changes that happened had the almost same trend as those given above. The built-up area of 9720ha and changed to 47480ha. Agriculture land increased from 13000ha to 17700ha. Forest land decreased from 17470ha to 9340ha. The waterbody decreased from 1560ha to 600ha. Barren land decreased from 48910ha to 15540ha (Shah et al., 2021).

### *Punjab*

Rawalpindi is the fourth largest city in Pakistan. It is situated on the Pothohar plateau and contains centuries-old ancient history (Kamran et al., 2022). The meaning of Rawalpindi is the abode of Rawals which is a tribe named Jogi (Ahmad et al., 2015). Rawalpindi consists of LULC classes of built-up, forest, barren land, barren mountains, and agriculture. This study was done from 1990 to 2020. Built-up area increased from 2561.02ha to 15,231.61ha. Forest land decreased from 4930.55ha to 1973.82 ha. Barren land decreased from 7156.52ha to 2671.31ha. Agriculture decreased from 8718.39ha to 2999ha. Barren Mountains increased from an area of 1291.87ha to 2907.82ha. Waterbody decreased from 1242ha to 117.18ha (Mannan et al.,2021).

Lahore is the second largest in Pakistan and the 26$^{th}$ largest city in the world (Asif, et al., 2020). A study was conducted to check out changes in Lahore city within the period of 20 years. The total area of Lahore city is 184240ha. It showed that Lahore mainly consists of four LULC classes that, are built-up, barren land, vegetation, and water. The difference from 1998 to 2018 was analyzed changes enlisted scientifically by GIS. Water class covered an area of 5041ha which changed to 1141ha in 2018. Built-up (settlements and constructions etc.) areas occupied 54977ha which increased to 75591 ha. Vegetation agriculture etc.) decreased from 45873ha to 41655ha. Barren land also decreased from 78344ha to 65859ha (Mumtaz et al.,2020). Recent research by Shah Fahad et al found the same results in Lahore city from 2000 to 2020. That study found an increase in built-up area with a percentage of 24.18. There is a decrease in agricultural land and barren land with 7.05% and 17.26% respectively. Waterbody shows a net change of 0.13% in the studied period of twenty years (Fahad et al.,2021). A combine LULC changes of temporal datasets of various LULC classes of Pakistan from 1979 to 2020 can be seen in figure 2.

Okara is surrounded on the west by the districts of Sheikhupura, Faisalabad, and Sahiwal, on the north by Kasur, on the south by Pakpattan and Bahawalnagar, and on the east, by India (Khalil, 2018). LULC change detection analysis was performed for the Okara district. Okara is around 437700ha. That study assumed to check change from 2000 to 2020. The land use land cover classes are vegetation (agriculture, crops, trees parks), built-up areas, Barren land, and water bodies. Vegetation area occupied the land of 392082ha which decreased to 381736ha. The built-up area

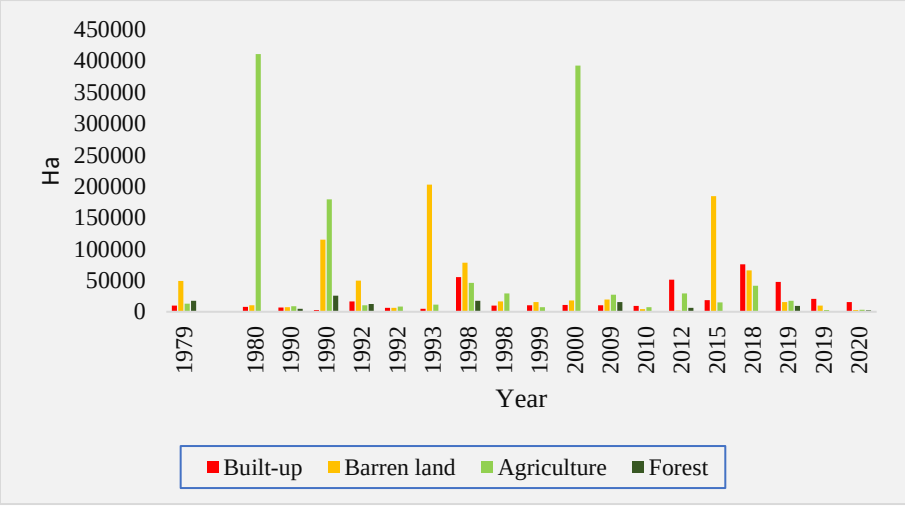


**Figure 2.** Temporal datasets of Built-up, barren land, agriculture, and forest areas in Pakistan

**Table 1: List of regional, district, and local-level LULC data sources and mapping in Pakistan**

| Research type | Spatial coverage | Data resources | Temporal coverage | References |
|---|---|---|---|---|
| **LULCC** | Islamabad | Landsat data | 1992 to 2012 | (Hassan et al., 2016) |
| **Land Degradation** | Islamabad | Landsat data ancillary data | 1979 to 2019 | (Shah et al., 2021) |
| **Urban growth** | Rawalpindi | Landsat data | 1990 to 2020 | (Mannan et al., 2021) |
| **LULC** | Lahore city | Landsat | 1998 to 2018 | (Mumtaz et al., 2020) |
| **LULC Change** | Lahore | Landsat | 2000 to 2020 | (Fahad et al.,2021) |
| **LULC Change** | Okara | Survey data, Landsat | 2000 to2020 | (Hussain et al., 2022) |
| **LULC Change** | Faisalabad | Landsat | 1992 to 2010 | (Bhalli et al., 2013) |
| **LULC, LST** | Khanewal | Landsat | 1980 to 2020 | (Hussain et al., 2021) |
| **Temporal change, LST** | Multan Division | Survey data, Landsat, Census data | 1990 to 2020 | (Hussain et al., 2021) |
| **LULC, LST** | Multan District | Landsat | 1988 to 2017 | (Hussain et al., 2020) |
| **LULC Change** | Lodhran | Landsat | 1977 to 2017 | (Hussain et al., 2020) |
| **LULC change Climate change** | Jhelum | Survey data, Landsat | 1990 to 2020 | (Majeed et al., 2021) |
| **LULC** | Soan River | Landsat data ancillary data | 2002 to 2015 | (Bashir et al., 2017). |
| **LULC, SUHIs** | Karachi city | Landsat | 2009 to 2017 | (Rizvi et al., 2020) |
| **LULC** | Frontal Karachi coast | Landsat | 2010 to 2018 | (Khan et al., 2020) |
| **Urbanization** | Malir Basin | Landsat, rainfall data | 1993 to 2015 | (Zafar et al., 2019) |
| **Forest cover change** | Thatta | Landsat, Demographic data | 1990 to 2014 | (Qasim et al., 2016) |
| **Urban sprawl, LULC** | Quetta | Landsat | 1999 to 2019 | Bazai et al., 2020) |
| **LULC** | District Pashin | Landsat | 1992 to 2013 | (Khan & Qasim,2017) |
| **Deforestation** | Ziarat | Landsat | 2004 to 2013 | (Gul, et al., 2016) |
| **GIS analysis** | Sherani district | Landsat | 1999 to 2019 | (Urooj et al., 2020) |
| **Deforestation** | Swat | Landsat | 2000 to 2011 | (Ghaffar et al.,2016) |
| **LULC, Erosion risk mapping** | Muzaffarabad | Landsat, rainfall & temperature data | 1998 to 2009 | (Iqbal et al.,2014) |

increased from 10932ha to 30310ha. The barren land decreased from 17980ha to 11559ha. Water bodies decreased from 6846ha to 4235ha. These changes occur in this region due to different factors (Hussain et al., 2022).

Faisalabad (73-74o E, 30-31.15o N) is Pakistan's third largest city and an important industrial center (Javed et al., 2015). Total area Faisalabad city is 21300ha. A study was made from 1992 to 2010 to monitor the area statistics. It showed that Faisalabad mainly consists of built-up, agricultural, barren, and waterbodies. Built-up land consists of 6163.11ha and increased to 9480.44ha. The agricultural area decreased from 8454.14ha to 7307.67ha. Barren land decreased from 6071.49ha to 4207.91ha. Waterbodies showed an area of 701.56ha and decreased to 394.28ha. These changes were monitored in the third important city in Pakistan (Bhalli et al., 2013).

In Pakistan's Punjab province, Khanewal district is located in the Lower Bari Doab (between the Sutlej and Ravi rivers) at latitudes of 29.85° to 30.43°N and longitudes of 71.5° to 72.47°E (Akhter et al., 2016). LULC changes by supervised image classification were presented from 1980 to 2020. It showed the four classes representing an area of Khanewal district in Punjab. That is vegetation, built-up, bare soil, and waterbodies. Every class was calculated by area. Vegetation controls an area of 410622.21ha which decreased to 392654.65ha in 2020. Built-up area increases from 7640.81ha to 30623.24ha in forty years. Bare soil decreased from 10578.01ha to 7625.3ha. Waterbodies decreased from 7293.57ha to 5231.41ha from 1990 to 2020. These changes happened in the district of Khanewal (Hussain et al., 2021).

Multan division consists of four districts, Multan, Khanewal, Vehari, and Lodhran districts. A study at the division level revealed some important changes in this region. This region is fertile plains of rivers (Ravi & Sutlej) and is called Nilibar. It is famous for the cultivation of agriculture like cotton, wheat, sugarcane, rice cotton, etc. Rabbi and Kharif are two important seasons of cultivation in the cropping calendar of Multan. A study was carried out to know how Kharif and Rabbi crops change along with the built-up and waterbody of the Multan division. Change study of crops done within time duration from 1990 to 2020. Rabi census data showed that Rabi fodder was cultivated in an area of 185655.16ha in 1990 and increased to 280675ha in 2020. Kharif fodder also increases from 318615.6ha to 470177.37ha. Sugarcane decreased from 273827.24ha to 221766.66ha. The wheat decreased from 1165106.73ha to 1070775.22ha. Cotton areas decreased from 625973.33ha to 508358.75ha. Rice decreased from 385143.55ha to 356249.32ha. Waterbody decreased from 47417.05ha to 29058.81ha. Built-up (barren land) area increased from 130539.47ha to 195456.7ha. So, changes occur in crops along with built-up and waterbody (Hussain et al., 2021).

District Multan is located between 29° 22' and 30° 24' north latitude and 71° 03' and 72° 28' east longitude. It is located in a bend created by five rivers that meet there (Farooq, 2012). Rabi and Kharif crops are studied with other classes of built-up, barren land, and waterbody in subject with LULC classification from 1988 to 2017. The LULC classes that are dominant in the area are forest, crops of Rabi and Kharif, Built-up, barren land, and waterbody. Forest areas change from 9400ha to 5297ha. Change of wheat occurs from 252,372ha to 250,604ha. Sugarcane decreased from 12,940ha to 10,831ha. Cotton decreased from 121,845ha to 106,217ha. Rice decreased from 148,144ha to 122,197ha. Bare soil decreased from 40,236ha to 18,189ha. Cultivation of Some other crops increased from 26,532ha area to 32,291ha. Built-up area increased from 18,166ha to 44,581ha. Waterbody decreased from 5366ha area to 3219ha (Hussain et al., 2020).

Lodhran is a district, that was created in 1991 and is situated on the northern bank of the Sutlej River in Punjab, Pakistan. Multan, Khanewal, and Vehari districts are to its north, and Bahawalpur lies to its south (Ismail et al., 2010). LULC of Lodhran was calculated from 1970 to 2017. Classes of classification of this district mainly consist of vegetation, built-up, bare soil, and waterbody. The changes are also considerable. Vegetation and built-up increased by 1.6% and 4.3% respectively. Bare soil and waterbody decreased by 5.2% and 0.7% respectively. These changes occur within 30 years (Hussain et al., 2020).

The district of Jhelum is north of the Jhelum River and is bordered by the districts of Rawalpindi in the north, Sargodha and Gujrat in the south, Azad Jammu and

**Table 2: Relative percentage of change in respective year of study in Federal and Punjab**

| Study area | Temporal coverage | Land use Land cover relative % changes in respective occupied classes | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Built-up | Barren land | Agriculture | Forest | Water body | Vegetation | Barren mountain |
| **Islamabad** | 1992 to 2012 | +213.5 | −96.63 | +180.6 | −49.42 | +11.5 | _ | _ |
| **Islamabad** | 1979 to 2019 | +41.7 | -36.8 | +5.20 | -9.03 | -1.21 | _ | _ |
| **Rawalpindi & Islamabad** | 1990 to 2020 | +494.74 | −62.67 | −65.60 | −59.96 | −90.564 | _ | +125.08 |
| **Lahore city** | 2000 to 2020 | +24.18 | -17.26 | -7.05 | _ | 0.13 | _ | _ |
| **Okara** | 2000 to2020 | 64 | -55 | _ | _ | -61 | -2.71 | _ |
| **Faisalabad** | 1992 to 2010 | +35 | -44 | -16 | _ | -77 | _ | _ |
| **Khanewal** | 1980 to 2020 | +5.27 | −0.68 | _ | _ | −0.47 | −4.12 | _ |
| **Lodhran** | 1977 to 2017 | +4.3 | − 5.2 | _ | _ | − 0.7 | +1.6 | _ |
| **Jhelum** | 1990 to 2020 | +1.55 | -6.14 | 13.86 | -3.74 | -5.52 | _ | _ |
| **Soan river** | 2002 to 2015 | 49.04 | +137.32 | _ | _ | -58.81 | -53.24 | _ |

Kashmir in the east, and Chakwal in the west (Majeed et al., 2021). Lulc changes in district Jhelum are analyzed from 1990 to 2020. Classification showed that the area is dominated by forest, cultivated areas, river barren land, and built-up. Forests declined to a miserable level from 25,701.89 ha to 12,182.84ha. Cultivated areas occupied 179,025.57ha and increased to 229,096.76ha. The river area decreased from 34,742.13ha to 14,785.12ha. The barren land decreased from 114,885.09ha to 92692.62ha. Built-up area increased from 7030.51ha to 12,637.41ha (Majeed et al., 2021).

A major physical divide of Pakistan, the Pothohar Plateau, is drained by the river Soan, which has its source in the lower Himalayan foothills (Nazeer et al., 2014). The Soan River basin is classified as consisting of classes of vegetation, water, barren land, and urban areas. Land shift summary of Soan River depicted from 2002 to 2015. This summary shows that there is a decrease in vegetation and water with 53.24% and 58.81% respectively. Barren land increased to 137.32% and urban areas increased to 49.04% (Bashir et al., 2017).

***Sindh***

Karachi is situated next to the Arabian Sea in the Pakistani province of Sindh (Raza et al., 2019). Statistical inferences and analysis of change detection from 2009 to 2017 give changes of 9 years in Karachi city. The urban area had increased by a relative change of 17300ha. Waterbody decreased by 4000ha within the boundary of Karachi city. Vegetation within the city increased by 3900ha. Barren land decreased by 17200ha from 2009 to 2017 due to urbanization and industrialization (Rizvi et al., 2020). LULC changes had occurred in coastal areas of Sindh, particularly on Karachi port, Bundle / Bhundar island, Karachi shipyard, PNS Himalaya Sandpit, and Far Island mangrove forest. The changes were detected from 2010 to 2018. The major areas of change are vegetation changes with mangroves, built-up area changes, and waterbody changes in the frontal Karachi coast. Coastal environmental variations occur in reference sites. FKC showed a relative increase in built-up from 2010 to 2018 with 26,205.93ha. The moderately built-up areas relative decreased in FKC studied sites with 146,769.3ha. Dense Mangroves Forest decreased with a relative change of 5762.34ha. Moderately spread mangroves also relatively decreased with an area of 26100.81ha. Many anthropogenic activities also caused the relative decreased in waterbody with an area of 2786.76ha (Khan et al., 2020).

The total area of the Malir River basin is 225170ha out of which 93000 ha is within the boundary of Karachi city. Malir is a non–perennial river and consists of nine tributaries. It is the second most extensive system in this region. Classification of Malir shows that it is occupied by built-up land, cultivated land, natural vegetation, barren land, and waterbody. LULC is studied from 1993 to 2015. The barren land of Malir was 202791ha in 1993 and decreased to 184200ha. The built-up increased from 4723ha to 18400ha. Cultivated land increased by occupying the basin area by 11500ha in 1993 and 2015 increased to 14760ha. Due to the narrowing of drainage, the waterbody increased from 84ha to 140ha from 1993 to 2015 (Zafar & Zaidi, 2019).

**Table 3: Relative percentage of change in respective year of study in Sindh and AJK.**

| Study area | Temporal coverage | Land use Land cover relative % changes in respective occupied classes | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Built-up | Barren land | Agri-culture | Forest | Water body | Vegetation | Snow |
| **Karachi city** | 2009 to 2017 | +40.42 | -20.21 | _ | _ | -13.15 | +48.75 | _ |
| **Malir basin** | 1993 to 2015 | +74 | -10 | +22 | _ | +40 | +20 | _ |
| **Quetta** | 1999 to 2019 | +95 | -34 | - | _ | _ | -63.10 | _ |
| **District Pashin** | 1992 to 2013 | +5.84 | -9.78 | _ | _ | 0.05 | +3.89 | _ |
| **Sherani district** | 1999 to 2019 | _ | -12 | _ | _ | -35 | 44 | _ |
| **Swat** | 2000 to 2011 | _ | +46 | _ | -115 | -12 | _ | 27 |
| **Muzaffarabad** | 1998 to 2009 | 01.00 | 04.20 | _ | -02.70 | 00.05 | -02.60 | _ |

District Thatta is located in the southern part of Sindh. The soil is very fertile and holds the Indus Delta. The area is mainly fissured and consists of creeks that vary in width from a few meters to a hundred meters. Deforestation in Thatta was assessed from 1990 to 2014. Thatta is mainly occupied by Riverine Forest, Mangroves, Algal mats, Saccharum and Typha spp,

Mesquite (Grasses, Bushes) Soil (Wet Soil, Mudflats, Rocks), Sand (River Bed, Saline Area), and Water. Dense mangrove forest had an area of 15,227ha in 1990 which decreased to 8872ha in 2014. Sparse mangroves decreased from 92,407ha to 67463ha. Riverine Forest decreased from 45,128ha to 25888ha. It happened due to anthropogenic activities and areas converted into agriculture. Agriculture areas increased from 131,589ha to 186349ha within the studied period. It is increasing due to the increase in population. Mesquite (grasses, bushes) occupied an area of 189,009 in 1990 and increased to 216359ha in 2014. *Saccharum* spp. and *Typha* spp. had an area of 34,550ha in 1990 and decreased to 11894ha in 2014. Soil (wet soil, mudflats, rocks, sand, river bed, saline area) encircled an area of 251786ha in 1990 and 100908ha in 2014 of district Thatta. Algal Mats have a minimal change of 34,401ha to 24665ha from 1990 to 2014. Sand (river bed, saline area) contains an area of 19,508ha in 1990 and 10217ha in 2014. Waterways contained 233,354ha to 243143ha from 1990 to 2014 (Qasim et al., 2016).

### *Baluchistan*

Quetta is the capital city of Baluchistan and is surrounded by mountains and part of the Pashin Lora basin. Quetta is the 10$^{th}$ largest populous city in Pakistan and is located near the border of Afghanistan. The total area of Metropolitan Corporation Quetta (MCQ) is 33160ha. A study assessed LULC change in Quetta in a time duration of 20 years. This study shows that there are massive changes and these changes were scientifically acquired from 1999 to 2019. The built-up area of Quetta was 10514ha in 1999 and increased to 20503ha in 2019. This almost doubled in 20 years. This happened due to war in the neighboring country Afghanistan and other reasons unplanned housing, congestion, traffic, etc. Open areas (areas with no vegetation cover, sand, open space, bare soils, and uncultivated agricultural lands) are 15219ha which becomes less than 9920ha in 2019. The change in vegetation also occurs. The area in 1999 was 7431ha and changed to 2742ha (Bazai et al., 2020).

District Pashin is found in the northwest part of the province of Baluchistan and is one of the most fertile districts of Baluchistan. District Pashin has a rugged topography with lofty mountains and intermountain valleys. The classification of district Pashin revealed the four main classes that occupied that area. These are barren areas (stony areas, uncultivated agriculture land soil, void vegetative areas), Vegetation (all kinds of trees, grass, plants, agriculture), waterbodies, and built-up areas. In 1992 the built-up areas were 6.57% in 1992 and increased to 12.40% in 2013. The waterbody showed a percentage of 0.13% in 1992 of the total area and it increased to 0.18%. It is due to the construction of small dams on seasonal streams. Bare surfaces and barren land account major portion of the Pashin district. It also changed from 88.03% to 78.25% from 1992 to 2013. Vegetation increased from 5.28% to 9.17% from 1992 to 2013. The vegetative increase showed an increase in tube wells to facilitate agriculture in the district (Khan et al., 2017).

The smallest district of Baluchistan is Ziarat which consists of 2 tehsil and 7 union councils. This district is facing deforestation. Ziarat is a unique place due to the Juniper Forest that is considered to world's oldest juniper forest after California that are 5000 to 7000 years old. Sometimes that is referred to as living fossils. Three sample sites were considered for the deforestation study in Ziarat. The study sites were Batsargai reserved forest, Gohar reserved forest, and Sasnamana reserved forest. Batsargai reserved forest showed a clear cover change from 2004 to 2013. The change of area occurs from 251.5 ha to 216.9ha. The non-forest area becomes barren with 34.6ha. The total area of Gohar's reserved forest was 6.50 ha. The decrease in cover occurred from 6.48 ha to 6.05 ha from 2004 to 2013. The changing area was converted to non-forest or barren land with 0.42ha of land. Sasnamana reserved forest has deforestation of 27.2042 ha to 18.45 ha from 2004 to 2013. So, increase in deforestation in Ziarat is confirmed and shows a decline in the studied years (Gul et al., 2016).

Sherani is situated in the Sulaiman Mountainous Region (SMR) in Baluchistan. Sherani district has a dense and pure cover of chilghoza forest that is found at an elevation level of 2700 to 3400 m. *Pinus gerardiana* (chilghoza) is a gymnosperm that is found in KPK, Gilgit Baltistan, Kashmir, and Baluchistan in Pakistan. A study was carried out to monitor chilghoza in district Sherani, Baluchistan from 1999 to 2019. LULC classification revealed that Sherani mostly consists of mountains, barren land, olive, vegetation, waterbody, thick chilghoza forest, and sparse chilghoza areas. In the year 1999 thick chilghoza forest was 17400ha which decreased to 8478ha. In the year 2019, the area showed renewal and increased to 12700ha. That is due to the struggle of local people with the help of WWF. Sparse chilghoza forest showed an increase of 7750ha to 13990ha from 1999 to 2019. Vegetation (local flora and agriculture) increased from 3340 ha to 13700ha in the studied time. Waterbody decreased from 16530ha to 12230ha. The olive area increased from 13600ha to 20240ha. Barren areas decreased from 11700ha to 10440ha. The mountainous area also decreased from 47330ha to 34340ha. That area decreased due to planting trees on mountains. Different plantation drives from government officials help the conservation of chilghoza and olive production (Urooj et al., 2020).

### *Khyber Pakhtunkhwa*

District Swat is located in Khyber Pakhtunkhwa and consists of 8 tehsils which are Babuzai Bahrain, Barikot, Charbagh, Kabal, Kalam, Khawaza Khel, and Matta. A study shows the land cover features of district Swat. The main LULC features of swat are snow, forest, bare land, and water bodies. Scientific study shows a difference of 11 years in area of interest. The forest cover of swat has an area of 281919.42ha to 130875.12ha within 11 years. Snow occupied 102543.42ha and showed a change of 140647.41ha in 2011. Bare land of swat was 134681.04ha in 2000. That figure changed to 248512.41ha in 2011. Waterbody decreased from 3013.02ha to 2676ha. These changes revealed the deforestation in Swat and the increase of barren land in the district of Swat (Abdul, Hira, & Abdul, 2016).

11 years. Bare soil increased from 16300ha to 19400ha in a studied period. Waterbody increased from 1460ha to 1500ha in 11 years. In this study, major losses were witnessed in the forest and low vegetation whereas gains occurred in built-up and bare soil (Iqbal et al., 2014).

## CONCLUSIONS

Different studies conclude some remarkable results in land use land cover change in Pakistan that have been deduced from a literature survey. Overall relative percentages have been inferred in Tables 2,3 and Table 4. All big and small cities like Karachi, Lahore, Rawalpindi, Multan, Okara Faisalabad, Khanewal, Jhelum, Lodhran, Quetta, and Pashin showed increases in settlements and manufactured structures with relative percentages of 40.42%, 24.18%, 494.74%, 7.2%, 64%, 35%, 5.27%, 1.55%, 4.3%, 95%, and 5.84% respectively. The built-up structure of all studied areas increases showing a rapid increase in urban growth with the corresponding impact on the environment. Successive growth of the area with increasing infrastructures and developing industries occupied the regions that are the symbol of progress and growing activities in the country. The bare land class of Lulc classification is land that is infertile and not in any use. This paper infers that almost all the study sites except the Soan Basin and Swat showed a decrease in the barren land. This land was converted to other classes of the respective area. Utilization of barren land for industrial and commercial activities is good for progress. The decrease of barren land within the studied time occurs in Federal and Punjab areas like Islamabad, Rawalpindi, Lahore, Okara,

**Table 4: Relative percentage of change in respective year in areas of deforestation and Multan**

| **Multan Classes (1988-2017)** | Relative % Change | Ziarat Classes (2004-2013) | Relative % change | Thatta Classes (1990-2014) | Relative% Change | FKC Classes (2010- 2018) | Relative% Change |
|---|---|---|---|---|---|---|---|
| **Forest** | −1.1 | Batsargai RF | -7.56 | Dense mangroves | -41.73 | Built-up | +48.19 |
| **Wheat** | −0.5 | Gohar RF | -6.48 | Sparse Mangroves | -26.99 | Moderately Built-up | -87.82 |
| **Sugar-cane** | −0.6 | Sasnamana RF | -47.44 | Algal mats | -28.30 | Dense mangroves | -35 |
| **Cotton** | −4.3 | _ | _ | Saccharum & Typha spp | -65.57 | Moderately spread mangroves | -59.36 |
| **Rice** | −7.1 | - | _ | Agriculture | +41.61 | Waterbody | -9.92 |
| **Built-up** | +7.2 | - | _ | Water | +4.19 | _ | |
| **Water-body** | −0.6 | - | _ | Sand | -47.62 | _ | |
| | | | | Riverine Forest | -42.63 | | |

### *Azad Jammu & Kashmir*

Azad Jammu and Kashmir (AJK) is situated in the northeastern part of Pakistan, in the Himalayan mountainous region. A study was implemented from 1998 to 2009 in two subdivisions of Muzaffarabad a part of AJK. This study shows this area's classes: forest, barren soil, low vegetation, built-up, and waterbodies. The change detection analysis showed the changes and interconversion of these classes to each other. The Forest area in this region is of 17550ha in 1998 and changed to 15550ha in 2009. Low vegetation (farm trees shrubs, agriculture) showed 29260ha of area in 1998 and changed to 27300ha in 2009. Built-up was 9600 ha and changed to 10360 ha from 1998 to 2009. So residential area increases within

Faisalabad, Khanewal, Lodhran, and Jhelum with relative percentages of 36.8%, 62.67%,17.26%, 55%, 44%, 0.68%, 5.2%, and 6.14% respectively given in table 2 and table 3.

Deforestation occurs due to an increase in population and the cutting of trees for fuel etc. Deforestation in Ziarat, Swat, Frontal Karachi coast Thatta, Islamabad Jhelum, and Rawalpindi occurred in the respective years of study. Batsargai, Gohar, and Sasnamana Reserved Forests decrease in Ziarat with the relative percentages of 7.56, 6.48, and 47.44 respectively. Deforestation in Swat arises from 2000 to 2011. A Decrease in Mangroves is witnessed that is found in FKC in areas of Karachi Shipyard, Bundal Island, PNS Himalaya, and Sandspit. In these areas, dense mangroves and sparse mangroves decrease by 35% and 59.36%. Thatta also faces deforestation of mangroves with 41.73 %, and 26.99% in dense and sparsely spread mangroves respectively.

Reforestation of chilghoza and olive in the Sherani district occurs with increased input from local people, the government, and WWF. Jirga community helps to restore the chilghoza forest by realizing the importance of internationally recognized Pakistani chilghoza nuts. Additionally, the migration of people from Sherani to other well-developed areas, increased usage of solar panels by some NGOs, and, awareness in the community against deforestation play a part in the restoration of chilghoza and olive areas. Olive and sparse chilghoza were restored with percentages of 48.82% and 80.51% respectively.

Agriculture is the main attribution of district Multan and related areas. Decreases in agricultural practice are due to increasing practices of built-up, occupation of agricultural areas by industries, irrigation water availability, farmer's decision, climatic conditions, and the demand of the market. Some of the rabbi and Kharif crops- wheat, rice, cotton, and sugar cane showed a decrease in cultivation with relative percentages of 0.5, 7.1, 4.3, and 0.6 respectively within study years. Water has different trends across the country. Some areas have a decrease in water availability and others show an increase in water. Climatic conditions and changing weather patterns are the possible causes behind it. Soan basin showed a decrease in water availability in terms of the area of Soan River that decrease with a relative percentage of 58.81. In contrast, the Malir River basin showed an increase in water in terms of land cover area with a relative area increase of 40%.

Monitoring of land use land cover changes is the urge of time for sustainable development, agronomic activities, wise usage of natural resources, protection of biodiversity, and forest monitoring, with all of the natural and anthropogenic activities including all positive and negative aspects of the environment. Land cover change is the most significant aspect of changing the environment worldwide, which is affecting the environmental systems thereby changing the climate. Land use land cover change is a fundamental approach to managing natural resources. Anthropogenic activities like grazing, industrialization, mining, and agricultural land are the key drivers of Lulc change. These human activities put anthropogenic pressure directly or indirectly on local areas and are at constant risk. So, it is important to apply a geospatial approach to assess the concerned domains like change in watershed, environmental services, and urban development.

## CONFLICT OF INTEREST

There is no conflict of interest for this manuscript.

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